CLAIMS

1-27. (Cancelled)

28. (New) A method of determining a position estimate based on an updated Kalman filter, comprising:

receiving a first measurement L_1 based on a first signal with wavelength λ_1 and frequency f_1;

receiving a second measurement L_2 based on a second signal with wavelength λ_2 and frequency f_2;

selecting a model α of distance dependent and distance independent errors in the first and second measurements, wherein the model α is selected from $\alpha = \lambda_1/\lambda_2$, $\alpha = \lambda_2/\lambda_1$, and $\alpha = 1$;

based on the model α, calculating a double differenced variance matrix:

$$D(L_1, L_2) = \begin{vmatrix} D_{11} & 0 \\ 0 & \overline{D}_{22} \end{vmatrix};$$

wherein

$$D_{11} = 2R_{L2}^2 \begin{vmatrix} W_1 + W_{ref} & W_{ref} & \cdots & W_{ref} & W_{ref} \\ W_{ref} & W_2 + W_{ref} & \cdots & W_{ref} & W_{ref} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ W_{ref} & W_{ref} & \cdots & W_{n-2} + W_{ref} & W_{ref} \\ W_{ref} & W_{ref} & \cdots & W_{ref} & W_{n-1} + W_{ref} \end{vmatrix};$$

wherein

$$\overline{D}_{22} = (R_{L2}^2 + \alpha^2 R_{L1}^2 - 2\alpha R_{L1,L2}) \begin{vmatrix} W_1 + W_{ref} & W_{ref} & \cdots & W_{ref} & W_{ref} \\ W_{ref} & W_2 + W_{ref} & \cdots & W_{ref} & W_{ref} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ W_{ref} & W_{ref} & \cdots & W_{n-2} + W_{ref} & W_{ref} \\ W_{ref} & W_{ref} & \cdots & W_{ref} & W_{n-1} + W_{ref} \end{vmatrix};$$

wherein

$$R_{L1} = (\frac{1}{\lambda_1^2}[R_{non-dist,L1}^2 + (R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot B^2])^{\frac{1}{2}};$$

wherein

$$R_{L2} = (\frac{1}{\lambda_2^2}[R_{non-dist,L2}^2 + (R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot B^2])^{\frac{1}{2}};$$

wherein

$$R_{L1,L2} = \frac{1}{\lambda_1 \lambda_2}(R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot (\frac{f_1^4}{f_2^4} R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot B^2;$$

wherein $R_{non\text{-}dist,L1}$ is a non-distance dependant measurement error for the L_1 measurement;

wherein $R_{non\text{-}dist,L2}$ is a non-distance dependant measurement error for the L_2 measurement;

wherein R_{ion} is measurement error due to ionospheric delay;

wherein R_{trop} is measurement error due to tropospheric delay;

wherein R_{orb} is measurement error due to orbit bias;

wherein each W is: $W_n = 1.0 + 7.5e^{-E/15}$;

wherein n is a satellite ordinal of a plurality of satellites;

wherein W_{ref} corresponds to a reference satellite of the plurality of satellites;

wherein E is the elevation angle of each satellite of the plurality of satellites;

updating a Kalman filter with the calculated variance matrix; and

determining a present position estimate based on the updated Kalman filter.

29. (New) The method of claim 28, wherein the updated Kalman filter with the calculated variance matrix is $K = D(L_1, L_2)_{new} H_2^T \{H_2^T D(L_1, L_2)_{new} H_2^T + V_2\}^{-1}$;

wherein H_2^T is a transpose of a design matrix H_2 for the measurement L_2;

wherein V_2 is a residual measurement of measurement L_2;

wherein $D(L_1, L_2)_{new} = D(L_1, L_2)_{old} - K_{old} H_2 D(L_1, L_2)_{old}$;

wherein $D(L_1, L_2)_{new}$ is the calculated variance matrix including the received measurements L_1 and L_2;

wherein $D(L_1, L_2)_{old}$ is a previous calculated variance matrix which was calculated before receiving both of the received measurements L_1 and L_2; and

wherein K_{old} is a previous Kalman filter which was calculated before receiving both of the received measurements L_1 and L_2.

30. (New) A computer readable medium having computer-executable instructions, comprising:

receiving a first measurement L1 based on a first signal with wavelength λ1 and frequency f1;

receiving a second measurement L2 based on a second signal with wavelength λ2 and frequency f2;

selecting a model α of distance dependent and distance independent errors in the first and second measurements, wherein the model α is selected from $\alpha = \lambda 1/\lambda 2$, $\alpha = \lambda 2/\lambda 1$, and $\alpha = 1$;

based on the model α, calculating a double differenced variance matrix:

$$D(L_1, L_2) = \begin{vmatrix} D_{11} & 0 \\ 0 & \overline{D}_{22} \end{vmatrix};$$

wherein

$$D_{11} = 2R_{L2}^2 \begin{vmatrix} W_1 + W_{ref} & W_{ref} & \cdots & W_{ref} & W_{ref} \\ W_{ref} & W_2 + W_{ref} & \cdots & W_{ref} & W_{ref} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ W_{ref} & W_{ref} & \cdots & W_{n-2} + W_{ref} & W_{ref} \\ W_{ref} & W_{ref} & \cdots & W_{ref} & W_{n-1} + W_{ref} \end{vmatrix};$$

wherein

$$\overline{D}_{22} = (R_{L2}^2 + \alpha^2 R_{L1}^2 - 2\alpha R_{L1,L2}) \begin{vmatrix} W_1 + W_{ref} & W_{ref} & \cdots & W_{ref} & W_{ref} \\ W_{ref} & W_2 + W_{ref} & \cdots & W_{ref} & W_{ref} \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ W_{ref} & W_{ref} & \cdots & W_{n-2} + W_{ref} & W_{ref} \\ W_{ref} & W_{ref} & \cdots & W_{ref} & W_{n-1} + W_{ref} \end{vmatrix};$$

wherein

$$R_{L1} = (\frac{1}{\lambda_1^2}[R_{non-dist,L1}^2 + (R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot B^2])^{\frac{1}{2}};$$

wherein

$$R_{L2} = (\frac{1}{\lambda_2^2}[R_{non-dist,L2}^2 + (R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot B^2])^{\frac{1}{2}};$$

wherein

$$R_{L1,L2} = \frac{1}{\lambda_1 \lambda_2}(R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot (\frac{f_1^4}{f_2^4} R_{ion}^2 + R_{trop}^2 + R_{orb}^2) \cdot B^2;$$

wherein $R_{non\text{-}dist,L1}$ is a non-distance dependant measurement error for the L_1 measurement;

wherein $R_{non\text{-}dist,L2}$ is a non-distance dependant measurement error for the L_2 measurement;

wherein R_{ion} is measurement error due to ionospheric delay;

wherein R_{trop} is measurement error due to tropospheric delay;

wherein R_{orb} is measurement error due to orbit bias;

wherein each W is: $W_n = 1.0 + 7.5e^{-E/15}$;

wherein n is a satellite ordinal of a plurality of satellites;

wherein W_{ref} corresponds to a reference satellite of the plurality of satellites;

wherein E is the elevation angle of each satellite of the plurality of satellites;

updating a Kalman filter with the calculated variance matrix; and

determining a present position estimate based on the updated Kalman filter.

31. (New) The computer readable medium of claim 31, wherein the updated Kalman filter with the calculated variance matrix is:

$$K = D(L_1, L_2)_{new} H_2^T \{H_2^T D(L_1, L_2)_{new} H_2^T + V_2\}^{-1};$$

wherein H_2^T is a transpose of a design matrix H_2 for the measurement L_2;

wherein V_2 is a residual measurement of measurement L_2;

wherein $D(L_1, L_2)_{new} = D(L_1, L_2)_{old} - K_{old} H_2 D(L_1, L_2)_{old}$;

wherein $D(L_1, L_2)_{new}$ is the calculated variance matrix including the received measurements L_1 and L_2;

wherein $D(L_1, L_2)_{old}$ is a previous calculated variance matrix which was calculated before receiving both of the received measurements L_1 and L_2; and

wherein K_{old} is a previous Kalman filter which was calculated before receiving both of the received measurements L_1 and L_2.